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(71) Applicant

Translift Material Handling Limited

(Incorporated In the United Kingdom)

Padgets Lane, Moonsmoot South Industrial Estate,  
Redditch, Worcestershire, B98 0RA, United Kingdom

(72) Inventor

Frederick Leslie Brown

(74) Agent and/or Address for Service

Shaw, Bowker &amp; Folkes

Whitehall Chambers, 23 Colmore Row, Birmingham,  
B3 2BL, United Kingdom(51) INT CL<sup>5</sup>

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B7H HA HXG H101 H102 H103 H204 H205 H211  
H215 H307 H620 H741 H744 H751

(56) Documents cited

GB 2234214 A

GB 1588716 A

GB 1553831 A

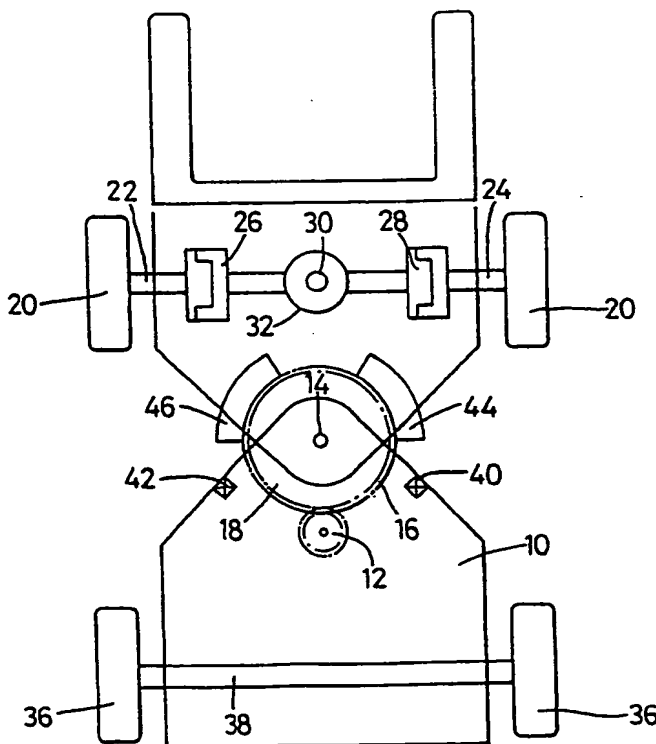
(58) Field of search

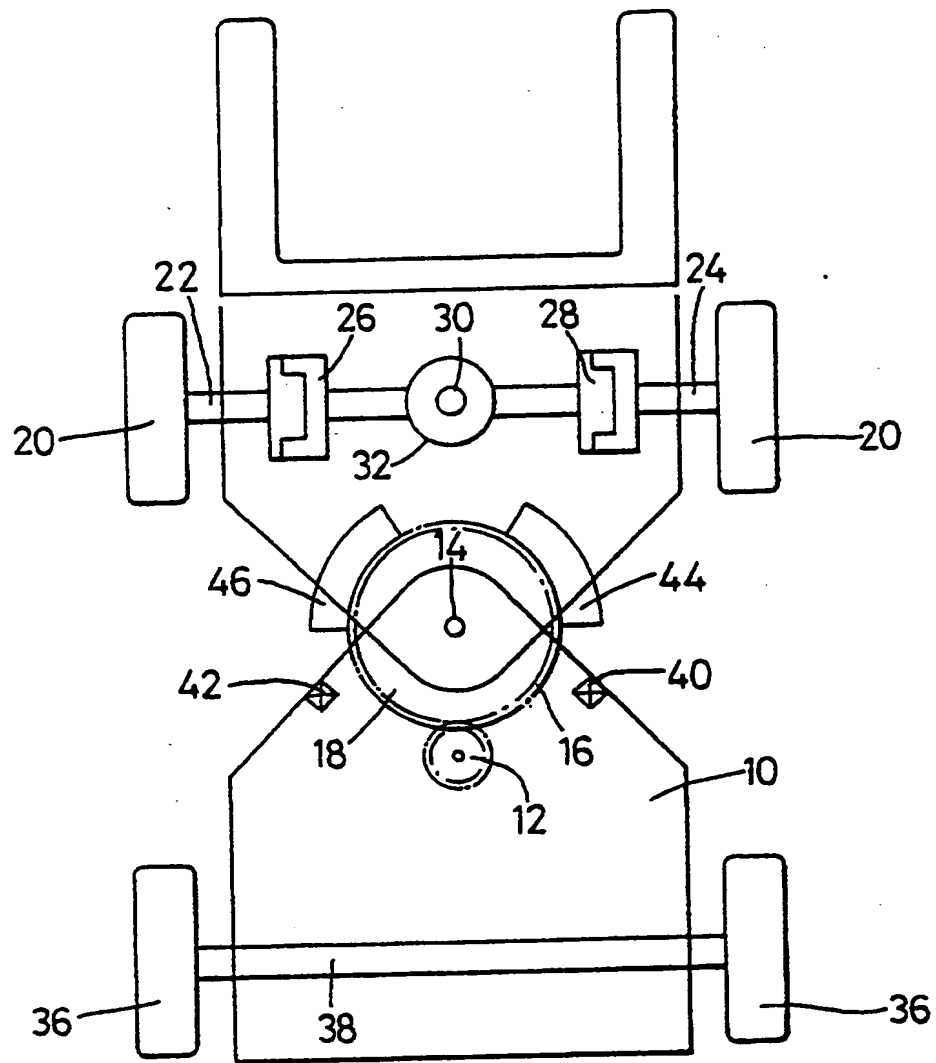
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## (54) Narrow-aisle fork-lift truck

(57) The truck comprises a front part pivotally connected to a rear part via a king pin 14. A steering motor drives gear 12 meshed with gear 18 to cause the steering effect. The front wheels 20 are driven by a motor 30 via differential 32 and clutches 26, 28 are located in the respective half shafts 22, 24. When the steering angle exceeds a predetermined amount, eg 45 degrees, in either direction, the corresponding clutch is actuated to disconnect drive to the wheel which is nearer to the centre about which the truck is turning. Thereafter the outside one of the wheels 20 is driven and the other three are free to turn in either direction or remain stationary as the vehicle is manoeuvred by the driver. The drive may be hydrostatic with a motor in the rear part driving a pump feeding a motor at each driven wheel. At the threshold steering angle, a spool valve cuts the supply to the inner wheel motor. Alternatively, the drive may be electric with an electric motor for each driven wheel, the inner motor being switched out of circuit at the threshold angle.





FORK LIFT TRUCK

This invention relates to narrow aisle fork lift trucks which are used in warehouses and which are to insert and remove loads generally at right angles to the aisles.

A conventional arrangement has the mast and forks, and hence the load, carried on a front part provided with a pair of wheels on a common fixed axis. This front part is pivoted to a rear part via a king pin generally at the centre of the vehicle. The rear part is counterweighted to balance the load and may carry a drive motor, propulsion batteries if used, and the driver. The rear part may have a single central driven wheel or more usually a pair of driving wheels on a fixed common axis. Steering is by turning the two parts relative to one another about the king pin.

Often the front part needs to be positioned at a large angle relative to the rear, which may be up to or even exceeding a right angle, especially if the driver mis judges the position of the vehicle relative to the required point in the stack and goes slightly beyond the desired turning point in load insertion or removal. These large angles cause rapid tyre wear and increase the risk of skidding, accident and instability. The most extreme example of this occurs when the driven rear wheel(s) attempts to push or pull the front wheels in the direction of their rotational axis, that is sideways relative to their normal direction of movement, but similar problems occur at smaller angles of turning.

DE 1049307A discloses an arrangement in which the front wheels are driven instead of the rear: each of the front wheels has its own independent drive motor which can be controlled independently of the other both as regards direction and speed. Since these trucks are necessarily one-man operated, one and the same person must at one and the same time perform many or all of the following operations:

1. Steer the truck in a narrow aisle.

- 2 Position it, i.e. steer it into a sharp turn precisely located so that the front of the truck is opposite the required point in the warehouse stack forming the aisle.
3. Control the speed in a general sense of overall speed
- 4 Control the nearside motor (on the inside of the turning circle) to prevent skidding
5. Likewise and independently control the motor on the outside wheel
6. (Possibly) raise the load from the lowermost position in which it is carried to the height required for load insertion.

All of this calls for great skill or more likely results in extremely low speed operation thus increasing the number of trucks and operators required in a particular warehouse

USP 4914592 teaches the idea of dispensing with the conventional steering means and apparently having axles fixed in relation to the vehicle, and then using movements of the steering wheel to control a pair of hydrostatic motors, one for each of a pair of wheels located on the axle. A steering wheel movement which in a conventional vehicle would move a track arm to swing an axle about a king pin instead. in a construction of this U.S. patent, causes one of the motors to slow down relative to the other. This causes the other motor driven wheel to travel faster than the one which is slowed down and hence the vehicle steers in a curve. The patentee calls this steering-by-driving and points out that carried to extreme. by reversing one motor relative to the other (and driving both at the same speed but in opposite directions) the vehicle can turn on a vertical axis midway between the wheels and this is called zero turning radius. This patent does not explain how this teaching may be applied in a multi axle vehicle.

The object of the present invention is to provide a new and simple solution to the tyre wear problem and simplify the driving of the truck at large steering

angles so as to avoid either extremely slow operation or extremely high driver skill being called for.

According to the invention a narrow aisle lift truck of the kind comprising front and rear parts of the truck pivoted together about a common king pin axis, a pair of wheels on a common axis on the front part and another pair of wheels on a second common axis on the rear part. a driver actuated steering wheel connected to means for turning the front part relative to the rear part about said king pin axis by causing a positive displacement of the one part relative to the other independent of the vehicle drive transmission, and a motor for driving the front wheels, is provided with means for effectively declutching the drive to the front wheel which is on the inside of the turn when the steering angle exceeds a predetermined value.

The term 'effective declutching' is to be interpreted according to the nature of the drive system employed. For example, if the drive is mechanical, it may be via half shafts extending from a central differential gear, and in this case there may be clutch effective between the differential and each wheel, for example a powder clutch located in the hub of the wheel, which can be electrically actuated selectively, so that when one clutch is de-energised there is no drive to that wheel and that wheel is free to turn in either direction or remain stationary. It will be appreciated that this goes further than the simple differential effect which merely allows one wheel to go slower than the other, since with a differential the wheels cannot turn in opposite directions when there is drive input to the differential.

If the drive is hydrostatic, a motor in the rear part may drive a pump which delivers hydraulic fluid to individual hydraulic motors associated with the respective wheels. Effective declutching in this case can amount to movement of a spool valve so as to terminate supply of fluid to the declutched wheel motor and open both sides of the same to exhaust.

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If the drive is electric, using separate electric motors for each wheel, supplied from storage batteries which are preferably mounted in the rear part. then the declutching will amount to switching the relevant motor out of circuit so as to leave the wheel free for turning or not, or for reverse turning.

The declutching means may be automatically actuated when the steering angle exceeds a predetermined amount which may be for example 45 degrees, that is when the front part and rear part are located at 135 degrees to one another. The outside wheel then drives the truck towards or away from the adjacent face of the aisle and the inside wheel is free to rotate in the same direction as the driven wheel. or when the steering angle increases further. is free to remain stationary whilst perhaps pivoting on the ground. At times, especially at extreme steering angles, but dependent upon the geometry of the truck. the inside wheel may turn in the opposite direction to the outer and driven wheel. The essence is that the inner wheel is free to turn forwards or backwards or not at all under the applied forces rather than being forced to turn by drive means.

Preferably the declutching means is primarily electrically operated, and this can be done by using the position of the steering wheel of the truck. Turning the steering wheel beyond a certain point corresponding to a selected steering angle may directly actuate a microswitch to cause the powder clutch, spool valve or circuit switch operation to effect the declutching. It will be appreciated that the microswitch or like means is duplicated. one causing declutching of the lefthand wheel and the other the righthand wheel, according to the direction of turning.

The positive steering means may comprise a pair of rams extending between two parts of the vehicle. one on either side of the king pin. one being extended and the other contracted when the steering wheel is moved. Alternatively there may be a steering motor driven in one or other direction to drive a gear or sprocket which

drives a ring gear or chain respectively to bring about the steering movements. The ring gear or chain, or the front part of the truck itself may carry the microswitches.

Another possibility is to provide an analogue of steering position by a pulse generator and operate the clutches by comparing the analogue with a read only memory

In the accompanying drawings the sole figure is a diagrammatic view of a truck according to the invention. The truck comprises a rear part 10 provided with a driver's seat, steering wheel, a speed controller similar to an accelerator pedal and a speed limiter i.e. a brake controller, and storage batteries to drive an electric motor.

The steering wheel is connected electrically to a steering motor driven gear 12 journaled on an axis on the rear part 10. The front part is pivotally connected to the rear part via a king pin and the axis of the king pin is indicated by the reference 14.

A gear ring 16 is fast with front part 18 and concentric with axis 14. The front part has a pair of road wheels 20 connected by drive shafts 22 24 via clutches 26 28 and to a drive motor 30 which could be connected via a differential 32

The rear part has freely and independently rotatable wheels 36 on a common axis 38

The part 10 has microswitches 40 42 which may be proximity switches (or of any other desired nature) which are effected by the wiper parts 44 46 at appropriate steering angles

When the truck is in use the driver simply steers it and controls the speed. When the steering angle is sufficiently large, one or other clutch is actuated to disconnect drive to the corresponding wheel. Thereafter

until the steering angle is reduced. the truck effectively has only one wheel driven and three free to turn in any direction or not independently or individually. and the driver has complete control over the steering in the conventional manner. It is believed that this allows more precise steering than is possible in actual practice with a "steering-by-driving" arrangement and is very considerably simple to construct and operate. The result is a reduction in tyre wear and the possibility of relatively unskilled drivers operating the truck satisfactorily



CLAIMS

1. A narrow aisle lift truck comprising front and rear parts of the truck pivoted together about a common king pin axis, a pair of wheels on a common axis on the front part and another pair of wheels on a second common axis on the rear part, a driver actuated steering wheel connected to means for turning the front part relative to the rear part about said king pin axis by causing a positive displacement of the one part relative to the other independent of the vehicle drive transmission, a motor for driving the front wheels, and means for effectively declutching the drive to the front wheel which is on the inside of the turn when the steering angle exceeds a predetermined value.
2. A truck as claimed in Claim 1 wherein the clutches are electrically operated by signals generated when the steering angle exceeds a predetermined amount.
3. A truck as claimed in Claim 2 wherein the clutches are powder clutches.
4. A truck as claimed in Claim 1 wherein the drive means comprises a single electric motor driving a pair of half shafts connected to the individual front wheels via the clutches.
5. A truck as claimed in Claim 1 wherein the drive means comprise separate electric motors for each of the driven wheels.
6. A truck as claimed in Claim 4 wherein the motor drives the half shafts via a mechanical differential gear allowing one wheel to turn faster than the other in the same direction.
7. A truck as claimed in any preceding claim wherein the steering means comprises a motor driven gear or sprocket driving a further gear or sprocket concentric with the king pin axis.

8. A truck as claimed in Claim 7 wherein the steering means is provided with means for generating electric signals to operate one or other clutch according to the direction of turning.

**Relevant Technical fields**

(i) UK Cl (Edition L ) B7H (HA, HFJ, HXG, HXJ)

(ii) Int Cl (Edition 5 ) B62D 12/00

**Search Examiner**

J L TWIN

**Databases (see over)**

(i) UK Patent Office

(ii)

**Date of Search**

30 APRIL 1993

**Documents considered relevant following a search in respect of claims 1-8**

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2234214 A (TRANSLIFT MATERIAL HANDLING)	1,5
A	GB 1588716 (BUSHELL et al) - see example page 1, lines 32-44	1,5
A	GB 1553831 (COVENTRY CLIMAX) - see example page 1, lines 59-75	1,5

Category	Identity of document and relevant passages	Relevant to claim(s)

#### Categories of documents

**X:** Document indicating lack of novelty or of inventive step.

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**P:** Document published on or after the declared priority date but before the filing date of the present application.

**E:** Patent document published on or after, but with priority date earlier than, the filing date of the present application.

**&:** Member of the same patent family, corresponding document.

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